

Is Electroconvulsive Therapy Safe in the Presence of an Intracranial Metallic Object?

Case Report and Review of the Literature

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Background: Little is known about the use of electroconvulsive therapy (ECT) in patients with intracranial metallic objects. Theoretically, electric current might cause heating of the metal and damage of the surrounding brain tissue. Moreover, intracranial foreign objects increase the risk for epileptic phenomena and could thus complicate the treatment course.

Methods: The case of a man with intracranial bullet fragments as a result of a headshot, treated with ECT for mania, is presented. We conducted a PubMed literature search for other relevant cases.

Results: In our patient, ECT was completed without complication. Electroconvulsive therapy was safely administered in 22 published cases of patients with intracranial metallic objects.

Conclusion: After carefully weighing benefits and risks in each individual case, psychiatrists should not be reluctant to use ECT in patients with intracranial metallic objects. Apart from avoiding empirical dosage titration to minimize the exposure to current, positioning the electrodes to avoid the electric current of heating the metal, and continuing anti-epileptic agents in high-risk patients, no precautions need to be considered.

Key Words: ECT, intracranial metallic objects, safety

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Electroconvulsive therapy (ECT) is an effective treatment for the most severe psychiatric disorders, such as depression, mania, and psychosis.¹ Moreover, ECT is safe and generally well tolerated. There are no absolute contraindications to its use.² Some conditions, such as intracranial space-occupying lesions, are considered relative contraindications because of concern that an increase of the intracranial pressure during ECT would cause either bleeding or herniation. In recent reviews, however, both patients with intracranial masses³ and/or intracranial vascular lesions⁴ were reported to have safely undergone ECT. In a recent paper, Amanullah et al⁵ argue that ECT can be used safely in patients with skull defects and reviewed 9 cases of ECT in the presence of extracranial or intracranial metallic objects. The literature on ECT in the presence of intracranial metallic objects is scarce, and the physician is left without guidance. We describe the case of a 60-year-old man with bipolar disorder and with intracranial lead and bullet fragments as a result of a headshot. He was treated with ECT for a manic episode. Our main concern was that the electric current could cause the metallic objects to heat and cause subsequent damage to the surrounding brain tissue.

However, the outcome in our patient was good, with full recovery of the affective episode and no adverse outcomes. We present a review of all published cases on the use of ECT in patients with intracranial metal objects.

MATERIALS AND METHODS

We found out that metal often is used in the manufacturing of aneurysm clips (titanium) and coils (platinum), deep brain stimulation (DBS) electrodes (platinum and iridium), skull plates, and fixation systems. We conducted a PubMed literature search, focusing on English-, French-, German-, or Dutch-language articles from the inception of the database until August 2012, using the search strategy (“electroconvulsive therapy”[Title/Abstract] AND (“foreign object*”[Title/Abstract] OR “metallic object*”[Title/Abstract] OR “plate*”[Title/Abstract] OR “fixation system*”[Title/Abstract] OR “coil*”[Title/Abstract] OR “clip*”[Title/Abstract] OR “dbs”[Title/Abstract] OR “bullet”[Title/Abstract] OR “gunshot”[Title/Abstract])). We included all cases of ECT used in patients with intracranial foreign material of iatrogenic origin (skull plates, fixation devices, aneurysm coils, aneurysm clips, and DBS electrodes) and of noniatrogenic origin (bullet fragments and shrapnel). We excluded all cases of intracranial nonmetallic objects. Data published as posters or book chapters were not included. References of all relevant articles were then screened for additional papers.

RESULTS

Case Report

The case patient is a 60-year-old man of low normal intelligence (Wechsler Adult Intelligence Scale 79 at the age of 24) who has a diagnosis of schizoaffective disorder and Parkinson disease. The family history showed severe psychiatric disorders in 3 first-degree relatives. He has been hospitalized several times for episodes with affective and/or psychotic symptoms. There has been several suicide attempts. At the age of 26, he shot himself with one single shot in the head and precordial region. The entrance wound in the head was right parietal, and medical imaging soon after the attempt showed 2 small lead bullets and several bullet fragments. Several fragments were localized in the right paramedian parieto-occipital region. Others were localized in the right temporoparietal region. At the age of 60, he was hospitalized again in a high-care psychiatric setting because of a severe manic episode. At admission, he presented with mood instability, disinhibited behavior, decreased need for sleep, pressure of speech and psychomotor agitation, all of approximately 2 months’ duration. No psychotic symptoms were present. Neurologic examination showed cogwheel rigidity, tremor, bradykinesia, and decreased mobility, probably due to Parkinson disease. The patient had been treated successfully in the past with flupenthixol decanoate and olanzapine. Treatment

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at admission included clozapine, quetiapine, valproic acid, and L-dopa. Three months before admission, there had been 2 tonic-clonic epileptic seizures of unknown origin. Levetiracetam was started. Optimal antimanic psychopharmacological treatment became more and more compromised by the increasing need for dopaminergic anti-Parkinson medication on the one hand and by the risk of epileptic seizures when using neuroleptics in higher doses on the other. Electroconvulsive therapy was considered. Written informed consent was obtained and pre-ECT investigations were carried out. Serum analysis showed a blood cell count of $3.5 \times 10^{12}/L$ due to normochromic, normocytologic anemia of unknown origin. Levels of iron and folic acid were normal due to substitution therapy, and stool examination showed no evidence of anal blood loss. C-reactive protein was slightly elevated to 2.4 mg/100 mL with a normal leukocytosis. Thyroxine was decreased to 0.84 ng/dL with no clinical signs of hypothyroidism. Liver enzymes, creatinine, electrolytes, and thyroid-stimulating hormone were in normal level range. Relevant medical history reveals an episode of atrial fibrillation treated with electric reversion therapy and the subsequent administration of propranolol. Intramuscular injections of enoxaparin were prescribed to prevent arterial embolism. An electrocardiogram taken at admission was normal. Computed tomographic scanning and magnetic resonance imaging of the brain confirmed intracranial metal fragments located in the right occipital parafalcine region and right posterior periventricular region due to the past suicide attempt by gunshot in the head (Figs. 1, 2). Electroconvulsive therapy anesthesia consisted of glycopyrrolate, 0.2 mg; propofol, 60 mg; succinylcholine, 40 mg; and 100% oxygen. A brief-pulse stimulator Thymatron (Somatics, LLC, Lake Bluff, Ill) delivered the stimulus. Bifrontal electrode placement was used with a 1-ms, 70-Hz, 8-second, and 1014-milliCoulomb stimulus. This position of the electrodes was chosen to avoid the electric current from interfering with the metallic fragments located in the occipital brain regions. The patient reported no adverse effects, except for mild postictal headache for which paracetamol was given. The Young Mania Rating Scale (YMRS) at baseline was 43 and dropped to 29 after 5 ECT sessions. Electroconvulsive therapy was stopped after 10 sessions because of full remission (Young Mania Rating Scale score, 4). The Mini Mental State Examination was 29 at baseline and remained unchanged during and after the treatment. The Clinical Global Impression—Severity of Illness scale improved from 6 (severely ill) to 2 (borderline mentally ill) and the Clinical Global Impression—Improvement scale from 6 (much worse) to 1 (very much improved). The Unified Parkinson

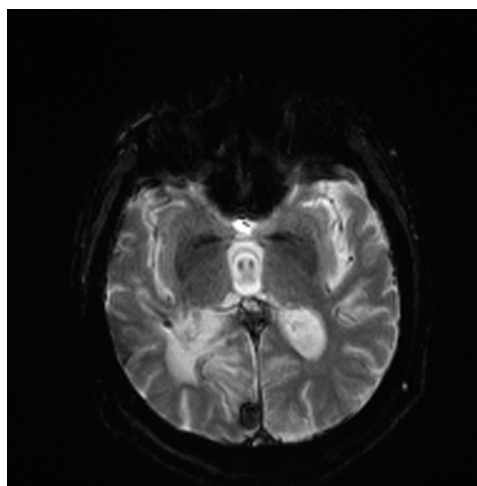


FIGURE 2. T2*-weighted magnetic resonance imaging showing a bullet fragment (black) in the right occipital parafalcine region and showing right-sided periventricular white matter lesions.

Disease Rating Scale also showed a marked improvement in posture, speech, stability, and brady-hypokinesia. Tremor disappeared almost completely.

Literature Review

Apart from this case, we found a total of 22 cases of patients who received ECT in the presence of an intracranial metal object. Characteristics of the 22 cases are presented in Table 1. In 19 cases, iatrogenic foreign metal objects (6 skull plates or fixation devices, 6 coils or clips, and 7 cases with DBS electrodes) were present. In 3 cases, the foreign objects were bullet fragments. In 5 cases, the objects were located in both hemispheres. In 7 cases, the objects were located in the right hemisphere; in 4 cases, the objects were located in the left hemisphere. In the remaining 6 cases, the exact location was not mentioned. In 19 of the 21 cases, a full recovery of the psychiatric disorder was reported. In one case, the outcome is not reported²⁶; and in one case,⁵ an improvement of depressive symptoms is mentioned but with remaining psychotic symptoms. Only in one early case, a possible complication due to the use of ECT was noted. Kooiker⁶ described the occurrence of fluid accumulation above the tantalum plate right after the use of ECT. There was a full spontaneous resorption of the fluid.

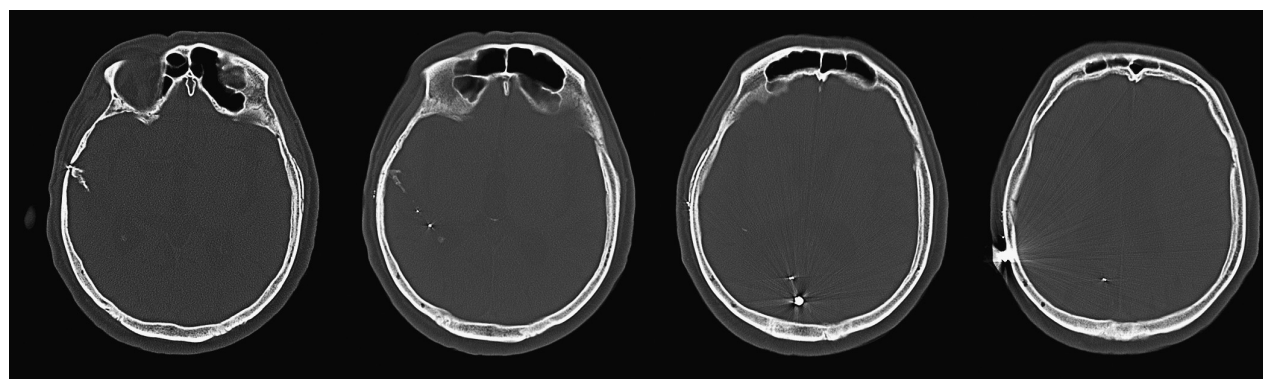


FIGURE 1. Computed tomographic scan of the skull showing metallic fragments along the bullet trajectory starting with an entrance wound at the right temporal region through the right posterior hemisphere ending in the region of the right occipital parafalcine region. There is also an extracranial metallic object located at the right temporoparietal region.

TABLE 1. Overview of Published Cases on the use of ECT With Intracranial Metallic Objects Present, by Publication Date

Authors (Year)	Sex, Age	Disorder	Object	Localization	CT/KST (post-ECT)	Precautions	ECT	Complications	Outcome
Kooker, ⁶ 1955	Unknown	Psychosis	Tantalum skull plate	Right parieto-occipital		None	BIL	Fluid accumulation over the plate	Improvement of depression but remaining psychotic symptoms
Ruedrich et al, ⁷ 1983	F, 21	MDD	Bullet fragments	Parietotemporo-occipital close to the falx cerebri		Phenobarbital to avoid status epilepticus and spontaneous seizures	Bitemporal	None	Full recovery
Husum et al, ⁸ 1983	F, 42	MDD	Clipping of an aneurysm	Upper part of the internal carotid artery		Hydralazine and propranolol IV to control BP Intensive monitoring of the BP		None	Full recovery
Crow et al, ⁹ 1996	M, 35	MDD History of chronic organic brain syndrome and seizure disorder	Bullet	Left middle cranial fossa		Re electrode 1.5 in above-standard location to keep the electrodes equidistant from the defect Continuation of phenytoin 300 mg/day	RUL	Mild confusion	BDI from 20 to 7 after the last treatment
Farah et al, ¹⁰ 1996	M, 60	MDD with psychotic and catatonic features	Aneurysm clip	Origin of the left posterior cerebral artery		Succinylcholine and propofol as anesthetic agents to afford better control of BP	BIL	Premature ventricular contractions and bigeminy after the first three sessions for which lidocaine was administered	Full recovery
Najjar et al, ¹¹ 1998	F, 66	MDD with catatonic features	Aneurysm clip	Right middle cerebral artery		First 2 sessions conducted at the PACU with arterial line monitoring	8 BIL and 4 RUL		Dramatic improvements
Moscarillo and Annunziata, ¹² 1999	F, 68	History of alcohol abuse DBS for essential tremor MDD	DBS electrode	Ventral nucleus of the thalamus	CT scan of the head after ECT showed that the DBS electrode was unchanged in position	Device was switched of Edge of the left electrode was positioned 2.5 cm from the edge of the subcutaneously tunneled extender cable	BIL	Recent and immediate memory were impaired on MMSE	Full recovery

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TABLE 1. (Continued)

Authors (Year)	Sex, Age	Disorder	Object	Localization	CT/KST (post-ECT)	Precautions	ECT	Complications	Outcome
Baker et al, ¹³ 2000	M, 34	MDD after brain injury	Metal prosthesis	Periorbital right		Electrodes placed more posteriorly	BIL		Significant improvement of mood (MADRS from 40 to 24)
Madan and Anderson, ¹⁴ 2001	M, 74	MDD with psychotic features	Stainless steel skull plate	Right temporoparietal region		Measurement of impedance before administration Electrodes placed left temporal and right frontal (3 cm above the supraorbital notch, 4 cm from the midsagittal plane)	BIL	None	Full recovery
Power-Connors and Pridmore, ¹⁵ 2003	F, 57	MDD	Aneurysm clip	Left infraclinoid internal carotid artery					Full recovery
Sharma et al, ¹⁶ 2005	F, 60	MDD	Surgical repairs for intracerebral aneurysms Aneurysm coil	Different sites Proximal segment of the right anterior cerebral artery (coil)		Succinylcholine and propofol as anesthetic agent to control BP Esmolol to control BP	BIL	Some retrograde amnesia	Full recovery, MADRS 6
Chou et al, ¹⁷ 2005	F, 66	DBS for PD MDD with psychotic features after DBS	DBS electrodes	Bilateral subthalamic nuclei	Post-ECT cranial MRI revealed no shift in electrode position	Device was switched off; electrodes were placed bilaterally over the frontal regions as far away from the DBS hardware as possible	BIL frontal	Some postictal confusion	Full recovery
Okamura et al, ¹⁸ 2006	F, 44	Psychosis/delirium (?)	Aneurysm coil	Basilar tip aneurysm		Succinylcholine and propofol as anesthetic agent to control BP	BIL	None	Full recovery (rigidity of the right upper limb)

Chang et al, ¹⁹ 2007	M, 63	History of PD	DBS electrodes	Right ventral intermediate thalamic nucleus	Device was switched off; one ECT paddle was placed approximately 5 cm anterior to the exit of the DBS electrode from the skull, and the other was placed more medially than normal to avoid the electrode as it traveled around the ear	Ultrabrief right unilateral ECT	None	Significant improvement
		MDD						
Singh et al, ²⁰ 2008	F, 72	MDD with psychotic features	Residual lead gunshot fragments	In the parietal, occipital and temporal bones of the skull	None	RUL	None	Full recovery
Bailline et al, ²¹ 2008	F, 78	History of PD - MDD	DBS electrode	Left subthalamic nucleus	Device was switched off	BIL	Some confusion after each ECT session	Mood significantly improved and delusional thinking disappeared; remaining feeling of anxiousness and restlessness
Glezer et al, ²² 2009	M, 53	MDD History of ADHD	Synthes titanium plating system with mesh and multiple connectors	Frontal	Modified RUL electrode placement to avoid unnecessary conduction through the metal prosthesis	RUL brief pulse	None	Remission of MDD
Puidgemont et al, ²³ 2009	F, 64	DBS for recurrent MDD	DBS electrodes	Bilateral subcallosal cingulate gyrus	Single brief-pulse stimulation (1 ms) without titration through threshold to minimize undue exposure to current	BIL bifrontal	None	Full recovery
Ling et al, ²⁴ 2010	M, 54	BD, manic episode and delirium	Titanium skull plates	Right frontoparietotemporal region	Changing the electrode positioning to avoid the metallic plate with one electrode on the left temporal region and one on the left occipital region	LUL, ultrabrief pulse	None	Marked improvement

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TABLE 1. (Continued)

Authors (Year)	Sex, Age	Disorder	Object	Localization	CT/KST (post-ECT)	Precautions	ECT	Complications	Outcome
Nasr et al, ²⁵ 2010	F, 56	History of PD MDD, recurrent and severe with psychotic features	DBS electrodes	Bilateral subthalamic nuclei		Device was switched off	BIL	None	Full recovery
Kaido et al, ²⁶ 2011	M, 57	BD	ZIP cranial fixation system	Occipital			Bilateral frontotemporal areas, brief pulse	None	
Ducharme et al, ²⁷ 2011	M, 71	History of PD MDD	DBS electrodes	Bilateral subthalamic nuclei		Device was switched off Placement of the electrodes was modified	Bifrontal	None	Full recovery

ACA indicates anterior cerebral artery; BDI, Beck Depression Inventory; BIL, bilateral; BP, blood pressure; CAT, computed axial tomography; CT, computed tomography; DBS, deep brain stimulation; MADRS, Montgomery-Åsberg Depression Rating Scale; MDD, major depressive disorder; MMSE, Mini Mental State Examination; MRI, magnetic resonance imaging; PACU, postanesthesia care unit; PD, Parkinson disease; SPECT, single-photon emission computed tomography.

DISCUSSION

Although there might be some concern that cases where the treatment resulted in brain damage were just not reported, from a review of 22 published cases, it can be concluded that the use of ECT in the presence of intracranial metallic objects can probably be performed safely. Our experience adds to this body of evidence. In the cases reviewed, no complications occurred. In the case described by Kooiker,⁶ where fluid accumulated above the skull plate, it is highly unlikely that ECT was the causal factor because similar transient fluid accumulations had been noted in this patient before the start of ECT.

The main concern in using ECT in the presence of intracranial metallic objects is that the electric current might cause heating of the objects and thus damage the surrounding brain tissue. Such adverse outcomes have been reported after medical procedures exposing patients with DBS electrodes to electric or radiofrequency energy. However, the underlying mechanisms are still unclear. Yamamoto et al²⁸ report a patient developing irreversible brain damage after cardioversion. The high-voltage electrical current of the chest wall was believed to have interfered with the subcutaneously implanted radiofrequency receiver that was connected to the stimulating electrode in the brain. However, the exact mechanism of brain lesioning could not be fully explained. Nutt et al²⁹ report on a patient with Parkinson disease and with implanted subthalamic DBS electrodes. He received diathermy treatment (a method to produce heat by radiofrequency waves used in several medical procedures) to the maxilla that produced dramatic brain damage and a subsequent vegetative state. Whether the radiofrequency energy interfered with the electrode wires en passage in the soft tissues of the neck or directly with the DBS electrodes in the brainstem was uncertain, although the latter was assumed. With the previous 2 reports in mind, the main concern of the authors who considered administering ECT to their patients with implanted DBS systems was that the electrical charge could interfere with the electrodes, either directly or by interference with the extension wires connected to the electrodes, thus heating them by inducing radiofrequency current. However, in the 7 cases of ECT in patients with DBS, no adverse effects were reported. It is believed that the risk of heating the electrodes is small because the energy needed to induce a seizure is low and far less than what is traditionally used for procedures like cardioversion.³⁰ Nevertheless, Medtronic (Minneapolis, Minn), manufacturer of DBS electrodes, states that the safety of ECT in patients who have an implanted DBS system has not been established. They put forward that induced electrical currents may interfere with the intended stimulation or damage the neurostimulation system components resulting in loss of therapeutic effect, clinically significant undesirable stimulation effects, additional surgery for system explantation and replacement, or neurological injury.³¹

Theoretically, one could estimate the risk of heating intracranial metal by electric power by taking into account the electric resistivity (p) of the metal (eg, lead, as in our case, was 2.2 nΩm at 300 K; titanium, a metal used in modern brain surgery in aneurysm clips and used in the case that Glezer et al²² describe in a Synthes titanium plating system, was 4.2 nΩm at 300 K; platinum, a metal used in aneurysm coils and DBS electrodes, was 10.8 nΩm at 300 K; tantalum, the metal used in a skull plate in the case Kooiker⁶ describes, was 13.5 nΩm at 300 K), the volumetric properties of the metal object (cross-sectional area [A] and length [l]) and the amount of electric current administered. The higher the resistance (R), the more heat an equal amount of electric power will cause (with R expressed in the formula $R = p \times l / A$). The amount of heat is then proportional to the square of the electric current

multiplied by this electrical resistance, a process known as ohmic heating or resistive heating. Two problems arise. First, the exponential fall in electric field strength with increasing distance from the electrodes makes it very difficult to estimate the amount of electric current that actually reaches the metal object. Second, the complex volumetric properties of the objects in almost all cases are not to be reduced to cross-sectional area (A) and length (l). Experimental research, as Deng et al³² did by using artificial 5-shell spherical heads in testing the possible effects of different ECT procedures on the brain when burr holes are present, is needed to provide absolute figures. However, from a pragmatic view, ECT uses low electric currents. Furthermore, as already mentioned earlier, because the exponential fall in electric field strength is away from the electrodes, the risk of heating a metallic object, if it is not located very close to the electrode, is most probably negligible. It is therefore advisable to choose the electrode position so that the current path does not cross close to the intracranial object. In our patient, a bifrontal placement was used because the metallic fragments were located posteriorly in the right hemisphere.

Indeed, several authors decided to change the position of the electrodes albeit for different reasons. In 5 of the 7 cases on ECT in the presence of DBS electrodes,^{12,17,19,22,27} the authors mentioned placing the electrodes as far away as possible from the DBS hardware to prevent electric current from interfering. Glezer et al²² and Ling et al²⁴ changed the position to avoid the current path from passing close to a titanium plating system²² and a titanium skull plate.²⁴ In the other cases, no preventive measures to prevent the current from interfering with the metal objects were mentioned. However, in several cases with skull defects,^{9,12,14,21,23} authors altered the electrode position to avoid the current from taking a low-resistance pathway more directly into the brain and to decrease the risk of electrolytic brain injury. This is in line with studies conducted on cadavers by Gordon³³ who found that if a skull defect was present, electricity entering the brain, from an electrode close to the defect, would be preferentially shunted through the defect. He theorized that this would result in concentration of current immediately below the defect, leading to a greater chance of brain injury. To minimize the risk of damage, he recommended that electrodes be placed equidistant from the defect and, in fact, found that if this was done, the current used would be similar to that of normal skulls. Therefore, a history of craniotomy is not a relative contraindication for ECT in accordance with the practice guideline for the treatment of psychiatric disorders of the American Psychiatric Association.²

As mentioned earlier, in the cases of ECT used when DBS electrodes are present, the position of the electrodes was altered to keep the electric current as far away from the DBS hardware as possible, especially the subcutaneously tunneled DBS lead extension cable, which typically runs posterior to the patient's ears. As Deng et al³² pointed out, this has no strong physical rationale because the DBS leads are insulated and hence, ECT-induced current cannot penetrate the wire (however, if there is evidence of wire insulation being damaged, neither DBS nor ECT stimulation should be applied). Deng et al further showed by modeling common methods of DBS electrode fixation on specially constructed artificial scalps that during the application of ECT, there might be a substantial increase of the electric field strength in the brain when the burr holes are not filled with an electrically insulating material and when the ECT electrodes are placed close to the burr holes. They warn that bifrontal ECT results in stronger and more focused induced electric field compared to right unilateral and bilateral placements, especially if the DBS electrode is anchored with metal plates. Choosing bifrontal electrode placement, as

Moscarillo and Annunziata¹² and Chou et al¹⁷ did in an attempt to place the electrodes as far away as possible from the extension wire, can end up in placing the electrodes closer to the burr holes, resulting in more current flowing through the burr holes. However, even in the experimental setting, which produced the largest increase in electric field strength and focality (bifrontal ECT with titanium burr hole covers), charge densities reached less than half the recommended safety limit for neural tissue damage ($40 \mu\text{C}/\text{cm}^2$ per phase).³⁴ Deng et al³² conclude that it is therefore unlikely that brain damage occurs but that clinical outcomes could be affected.

An alternative way to minimize risk is advocated by Glezer et al²² who skipped empirical dose titration to prevent the metallic object from repetitive undue exposure to electric current. However, no further arguments for this strategy were given.

Another concern in patients with intracranial foreign objects is the emergence of epileptic seizures. Ruedrich et al⁷ and Crow et al¹⁹ administered phenobarbital or phenytoin (postictal or as induction), respectively, to prevent epileptic phenomena, with success. Our patient had a history of tonic-clonic seizures, possibly secondary to the presence of the occipital lead fragments, in conjunction with high doses of neuroleptics (clozapine). We lowered the dose of clozapine and continued valproic acid throughout the treatment course. The treatment course was uneventful, and our patient made a full recovery. Manic symptoms disappeared, and motor symptoms improved substantially, corroborating the beneficial effects of ECT in Parkinson disease.^{35,36}

In patients where the metallic object is a coil or a clip to treat an aneurysm, it is advisable to prevent a rise in blood pressure. In 3 cases with a history of aneurysm repair,^{10,16,18} propofol and succinylcholine were used as anesthetic agents to attenuate hemodynamic changes due to the consecutive rise in parasympathetic and orthosympathetic tone during a convulsion. Husum et al⁸ decided to administer intravenous hydralazine and propranolol, and Sharma et al¹⁶ administered esmolol. Najjar and Guttmacher¹¹ monitored the blood pressure by an arterial line in a patient with a history of aneurysm clipping during the first 2 ECT sessions to provide an intensive monitoring of blood pressure and anticipate possible rise in blood pressure due to the ECT. The importance of the use of blood pressure-lowering anesthetic agents and frequent monitoring of the arterial pressure in patients with a history of brain aneurysm repair has already been shown in a review from Van Herck et al.⁴

In all cases on the use of ECT with DBS electrodes present, the authors switched off the device before administration. This was done to avoid triggering the device or destroying it. With one exception, the device was switched off during the whole ECT course, depriving the patient from the therapeutic effect of DBS during a significant period. Ducharme et al²⁷ were the first to turn the device back on immediately after each ECT session to prevent their patient from producing disabling tremor from Parkinson disease. Furthermore, they also describe leaving the device turned on during the sessions but putting it on 0 V. This was done to lower the risk even more of the DBS generator turning on and producing unwanted and possibly hazardous electric current during the treatment.²⁷

CONCLUSION

Electroconvulsive therapy in patients with intracranial metallic objects is probably safe. To avoid the theoretical risk of the electric current heating the metal causing damage to the surrounding brain tissue, the electrodes should be placed as far away from the metallic object as possible. In patients with DBS

electrodes and both burr holes and extension wires present, experimental evidence suggests that electrodes should preferentially be placed away from the burr holes because the extension wire has isolation. In all patients with intracranial metallic objects present, we also suggest avoiding unnecessary exposure to electric current by titration through threshold. In patients who have developed epilepsy as a consequence of the intracranial foreign object, antiepileptic treatment should be continued throughout the treatment course. In the absence of a history of epilepsy, in our opinion, there is no need to start anticonvulsant drugs. Psychiatrists should not be reluctant to use ECT in patients with intracranial metallic objects in need of ECT, carefully weighing possible risks and expected benefits. It is of importance to report cases like these to expand the knowledge base on the safe use of a valuable treatment as ECT.

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